ARI Research Note 90-42

Distributed Decision Making in Wildland Firefighting

Janie Taynor, Gary A. Klein,
and Marvin L. Thordsen
Klein Associates, Inc.

for

Contracting Officer's Representative
Judith Orasanu

Basic Research
Michael Kaplan, Director

July 1990

FIFTY YEARS OF SERVICE
1940 - 1990

United States Army
Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Research accomplished under contract for the Department of the Army

Klein Associates, Inc.

Technical review by

Judith Orasanu

NOTICES

DISTRIBUTION: This report has been cleared for release to the Defense Technical Information Center (DTIC) to comply with regulatory requirements. It has been given no primary distribution other than to DTIC and will be available only through DTIC or the National Technical Information Service (NTIS).

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The views, opinions, and findings in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY -- 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE --	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) KA-TR-858(A)-04F	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARI Research Note 90-42
6a. NAME OF PERFORMING ORGANIZATION Klein Associates, Inc. 6b. OFFICE SYMBOL (If applicable) --	7a. NAME OF MONITORING ORGANIZATION U.S. Army Research Institute Office of Basic Research
6c. ADDRESS (City, State, and ZIP Code) 800 Livermore Street P.O. Box 264 Yellow Springs, OH 45387-0264	7b. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences 8b. OFFICE SYMBOL (If applicable) PERI-BR	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-85-C-0327
8c. ADDRESS (City, State, and ZIP Code) Office of Basic Research 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO.: 61102B PROJECT NO.: 74F TASK NO.: WORK UNIT ACCESSION NO.:

11. TITLE (Include Security Classification)
Distributed Decision Making in Wildland Firefighting

12. PERSONAL AUTHOR(S)
Taynor, Janie; Klein, Gary A.; and Thordsen, Marvin L. (Klein Associates, Inc.)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM 85/07 TO 87/05	1990, July	51

16. SUPPLEMENTARY NOTATION
Contracting Officer's Representative, Judith Orasanu

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
~~Distributed~~ decision making ~~Expertise~~
Command and control systems, ~~Recognition-primed decision making~~
~~Naturalistic settings~~, fire fighting

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This study examined distributed decision making in a naturalistic context. The subjects--expert, command level, wildland firefighters--were studied as they made decisions about an ongoing set of wildland fires. Interviews were conducted using the critical decision method, which is a semi-structured technique for probing nonroutine incidents. Seventeen decision makers were studied, and a total of 110 decision points were probed. For most of the decision points, recognitional strategies were used. This was more pronounced for functional decision points. Analytic strategies were used in the majority of organizational decision points. Researchers found that the decision makers were heavily dependent on outside sources for critical information; sources within the organizational structure as well as sources from other organizations were frequently used. Comparisons were made to military comand-and-control organizations, and some conclusions were drawn regarding factors promoting effective distributed decision making. Keywords

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Judith Orasanu	22b. TELEPHONE (Include Area Code) (202) 274-8722 22c. OFFICE SYMBOL PERI-BR

DD Form 1473, JUN 86 Previous editions are obsolete.

ACKNOWLEDGMENTS

This study has been supported by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). The authors wish to thank Dr. Judith Orasanu for her encouragement and support. Thanks also to Roberta Calderwood, Beth Crandall, and Sterling Wiggins for their contributions to this paper.

We want to express our deep appreciation to the men and women in the U.S. Forest Service, the Bureau of Land Management, and the Boise Interagency Fire Control Center, without whose help and participation this study would not have been possible.

DISTRIBUTED DECISION MAKING IN WILDLAND FIREFIGHTING

EXECUTIVE SUMMARY

Requirement:

The goal of this study was to investigate decision strategies used by highly experienced commanders as they coordinated the efforts of thousands of firefighters during a large wildland fire. Researchers hoped to learn about decision-making strategies employed by command-level experts in a high risk, often rapidly changing, distributed environment.

Procedure:

This was an observational study in which highly expert, command level, wildland firefighters working within the Incident Command System were studied as they managed a large forest fire. Seventeen very experienced members of two national overhead teams served as participants in this study. Two observers at command posts used the critical decision method to collect data on the fire to determine the nature of the decision-making strategies these experts used while performing command and control activities.

Findings:

As predicted, these experts relied heavily upon recognitional decision-making strategies. This was more pronounced in areas in which they had the greatest expertise. At many decision points they did not need nor have the luxury of options. However, for decisions involving organizational issues and interpersonal negotiations, which were 28% of the incidents identified as critical, we found a predominance of analytical strategies in which several options were evaluated concurrently.

We did not find many of the complications of distributed decision tasks. There was little problem with information overload. Communication channels were limited but were used effectively. There was open communication about differences in the way situations were perceived and goals were formulated, but these were controlled so as to maintain team cooperation and morale.

Utilization of Findings:

The organizational structure we studied appears to represent a positive example of team decision making and offers a variety of lessons about what can be expected given the right blend of elements. These would include experience

level of commanders, opportunities for team training, coordination during previous operations, and incentives for overall organizational effectiveness. The decision makers' tasks in this study were not an exact match to those of military commanders, but these commanders did have the level of experience and expertise necessary to successfully employ recognitional decision strategies.

DISTRIBUTED DECISION MAKING IN WILDLAND FIREFIGHTING

CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

DISTRIBUTED DECISION MAKING IN WILDLAND FIREFIGHTING

Introduction

This study is one in a series intended to investigate decision making in natural settings. This line of research has focused upon environments in which strategic and tactical decisions must be made under conditions of risk, time pressure, extreme uncertainty, and where the consequences of chosen actions have high impact upon many people. Because of the target populations we have studied and our emphasis upon observing how decisions are made in real-world settings, our work has departed from more typical decision-making research and our findings have illuminated how decision makers in naturalistic settings behave. Our findings have revealed that command level, expert decision makers in high risk, action settings do <u>not</u> rely solely upon behavioral decision analysis. Instead, they rely upon recognitional processes for much of their decision-making activities and perform these processes very quickly (Klein, Calderwood, & Clinton-Cirocco, 1986; Calderwood, Crandall, & Klein, 1987; Brezovic, Klein, & Thordsen, 1987).

<u>Recognition-Primed Decision Making</u>

Standard research in decision making (e.g., Berkeley & Humphreys, 1982; Montgomery, 1983; Swezey, Streufert, Criswell, Unger, & van Rijn, 1984; Tversky, 1977) has primarily used inexperienced subjects and artificial tasks as the focus of study, concentrating upon testing prescriptive models such as decision analysis. Along with others (Rasmussen, 1985; Ebbesen & Konecni, 1980; Shanteau, 1984; Woods, 1984), our interest has been to study how <u>proficient</u> decision makers perform. Our own efforts have focused upon expert decision makers in real-world settings. Our purpose has been to develop a descriptive model of this type of decision making. Thus, our research has departed from earlier work on decision making in that our focus has been upon real world environments and upon the expert decision makers in these environments.

Two of our studies of naturalistic decision making (Klein, Calderwood, & Clinton-Cirocco, 1986; Calderwood, Crandall, & Klein, 1987) examined the decision-making activities of urban fireground commanders. These commanders were responsible for making decisions about how to allocate personnel and resources while fighting a fire. They had to struggle with many issues while making command decisions. For example, poor judgment in sending troops on to a roof could result in injuries and deaths. Delay could mean the loss of a building. Their decisions had to be made very rapidly, most being accomplished in less than a minute. It can be seen that the issues in this environment were real and had high impact.

Several important findings were obtained from these studies. First, there was little conscious, simultaneous, comparative deliberation of relative advantages and disadvantages of two or more options (as in decision analysis). Less than 12% of the cases in Klein et al. (1986) involved conscious comparative deliberation called concurrent deliberation. Less than 12.5% in the study by Calderwood et al. (1987) entailed concurrent deliberation of options at a decision point. At many

of the critical points in the fire where these experts gave commands, the experts themselves said that they had not made a decision! They repeatedly asserted that they did not deliberate options at points where they readily acknowledged that other action could have been taken or that someone else in the same circumstances might have taken a different course of action.

Calderwood et al. (1987) compared the decision-making strategies of very experienced commanders to those of relatively inexperienced ones. They found that the novice commanders engaged in more deliberation of options and less recognitional processes than did the more experienced commanders. They concluded that recognitional decision making is a salient characteristic of the experienced, expert decision maker.

If the expert fireground commanders were not deliberating among options what were they doing? Klein et al. (1986) contended that while the decision makers were performing their tasks, they recognized environmental situations that called for particular types of actions. These decision makers' expertise and experience allowed them to rapidly identify the salient aspects of the situation in which a decision point was embedded. Once the situation was so recognized, no choosing among alternative courses of action was needed. The appropriate course of action was triggered by the situation. Eighty percent of the decision points in the Klein et al. (1986) study were of this type.

When deliberation does occur at a decision point, it is not most typically the type which has been described in the decision analysis literature. Calderwood et al. (1987) found that the cognitive activity at a decision point focused heavily upon predecisional processes. When deliberation occurred in that study, it was most often about the nature of the situation In fact more deliberation occurred about the nature of the situation than about the selection of options.

The Recognition-Primed Decision (RPD) Model

A Recognition-Primed Decision (RPD) model has been postulated to explain the manner in which expert decision makers perform their tasks (Klein et al., 1986; Calderwood et al. 1987). The RPD model differs from the traditional model associated with behavioral decision analysis. The traditional model has little to say about the predecision processes.[1] It does not address the critical question of how options are generated. Its emphasis is upon the use of analytical methods to evaluate options.

The RPD model of naturalistic decision making emphasizes recognitional rather than calculational processes, serial rather than concurrent evaluation of options, and defines the ideal case as one in which only a single option is generated rather than an exhaustive set of options. (See Figure 1.)

---

[1]However, see Gettys (1983) for hypotheses about these processes.

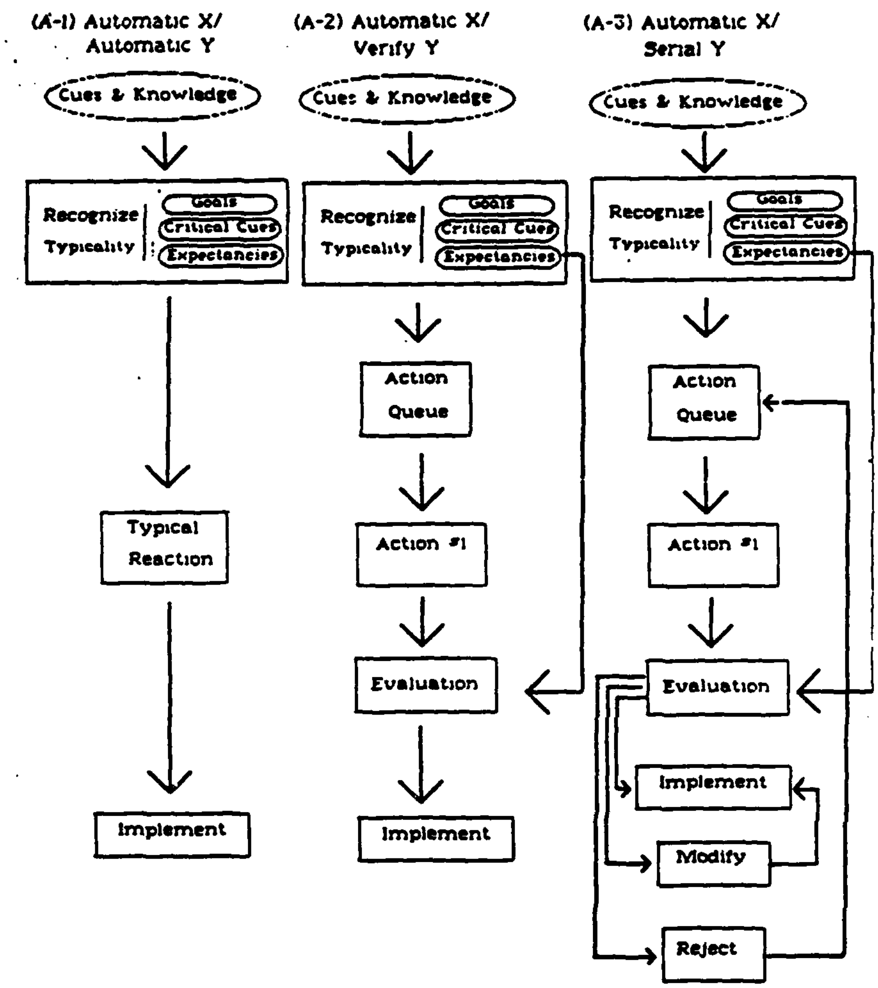


Figure 1 -- Recognition-Primed Decision Model

3

Standard environmental cues, as interpreted by the skilled decision maker, serve as inputs to the RPD model. The decision maker is presumed to have sufficient experience to recognize the familiarity of the cues or the case. Once the familiarity is appreciated, it may be verified; or, the initial recognition may be challenged, and the person may decide that superficial appearances were misleading and the situation must be reclassified. The RPD model does not necessarily require unconscious processing. All that it calls for is an emphasis of recognitional over calculational operations and the evaluation of options one-at-a-time until an acceptable one is found.

Once the situation is identified at an acceptable level of confidence the decision maker knows how to proceed. The judgment of typicality of the situation carries with it the typical reaction. The option can be evaluated and verified, time permitting. If necessary it can be modified or rejected. If the option is rejected another will be generated; there will be serial generation and evaluation until a suitable option is found.

The RPD model makes a distinction between the way expert decision makers interpret the situation and the way they select an option. As in a production rule, the situation X produces an action Y. A similarity may be seen between the RPD model and Rasmussen's (1985) description of rule-based performance.

In order to determine the strategies expert decision makers use in determining the nature of the situation and the way they find the appropriate option, Calderwood et al. (1987) began to code decision strategies along an "X" dimension for the understanding of the problem conditions and a "Y" dimension for the selection of an option. They, thereby, expanded the area of our exploration about expert decision making and provided the framework for viewing decision making in the present study.

Distributed Decision Making

In our earlier work we studied urban fireground commanders (Klein et al., 1986; Calderwood et al., 1987) and Army tank platoon leaders (Brezovic et al., 1987). In these decision making environments a single leader made decisions and gave orders to those under his command. The studies examined a single person in authority who gave orders to others.

The present research was conducted in a distributed decision-making environment in which strategic and tactical decisions were made in high risk and quite often rapidly changing situations. In this study, distributed decision making was required in order for the expert decision makers to perform their tasks. There was the need for group interaction and discussion on the choice and/or modification of options. In addition, there was the requirement for group interaction and input concerning the definition of the situation in which the decision behavior was embedded.

Distributed decision making has been most often cast in terms of selection of options. Fischhoff and Johnson (1985) describe distributed

decision making as a situation in which the choice of decision options is refined by the interaction of authority with lower levels of organizational responsibility. They state that communication for the different levels of authority in a distributed environment is a major determining factor dictating whether the system will work properly. They go on to say that effective communication and interaction is based upon a shared model among the parties in a decision. The model that the decision makers in the distributed environment share includes such things as the status of the internal and external situation and common beliefs about external forces that might affect the system. The shared model binds the organizational parts and allows communication to occur.

They contend that the degree of the match of models among the decision makers in a distributed environment affects the quality of decision making. The relationship between optimal decision making and sharing of models appears to be curvilinear. Too little sharing would disrupt or impede communication. Too much sharing would yield a false consensus.

These authors contend, and we would agree, that the communication process and the degree of model sharing in a distributed environment are key elements that distinguish it from situations in which a single decision maker has sole responsibility and control of the decision-making activity.

Study Objectives

Working within the frameworks outlined above, the present study is a continuation of the research on decision making in naturalistic settings. In this study we wanted to examine some of the boundary conditions affecting the use of recognitional strategies. Therefore, the first objective of this study was to test and refine the RPD model in an environment that contained a wide range of such features as time pressure, need for coordination with others, and risk. We hypothesized that the general findings of the urban firefighting studies would be obtained, but that there would be less recognition, more deliberation, and more analysis because of reduced time pressure in this setting and the need to coordinate with so many more people. We felt that such coordination would make perceptual and recognitional processes more difficult and would provide pressure for more analytical behaviors such as overt deliberation between options. Therefore, we did not expect as high a rate of RPDs in this study as in the earlier ones.

A second objective was to study the manner in which domain experts acquire and communicate the knowledge about their developing command situation. Because we had found the X dimension to drive much of the decision-making activities in our other studies, we wanted to examine how situational awareness was developed in a high risk, complex, and rapidly moving task environment. In addition, the way these experts learned about their situation occurred in a dramatically different manner in this environment than in our earlier research. Our previous studies had found that the experts learned about their situation primarily through their own

senses and efforts. For example, an urban firefighter can feel the heat of the fire and surrounding material and be sickened by toxic gases. The decision makers in the distributed environment of the present study could seldom rely solely upon their own direct perception of events to keep abreast with their situation. Consequently, these experts had to rely upon information from others.

Third, there were two types of decision points that were investigated in this study. In a command and control situation such as this one, the decision makers had need to call upon two types of expertise. First, they used their expertise in actual firefighting procedures. Second, they employed their skills in organizational behavior, utilizing expertise in negotiating for resources for implementing their own ideas. They had to exercise interpersonal skills and knowledge of the people and systems with whom they worked in order to accomplish their tasks effectively. We hypothesized that these decision makers, while very expert in both areas, would possess more expertise at functional decision points than at the organizational ones. Consequently, we hypothesized that more RPDs would be found at the functional decision points than at the organizational ones.

Method

The Setting

This was an observational study. We followed a group of well trained and disciplined command level wildland firefighters as they managed the command and control activities to fight a number of large forest fires. The fires consumed over 25,000 acres of timber and burned for a month. Twenty individual fires were in imminent proximity. One of these fires escalated to incorporate over 18,000 acres of land (28 square miles) before it was brought under control. Over two thousand people were needed to fight that fire. Four thousand people were needed to combat all the fires in the area.

This setting was chosen for several reasons. These firefighting experts work within the Incident Command System which is a useful analogue for studying military command and control problems. It is divided into multiple functions, similar to a military organization. Consequently, the Overhead fire teams have expertise and experience not only in fighting fires, but also in managing the other functions that support the fire suppression activities. Many people were involved in fighting these fires. We had the opportunity to observe decision making at several tiers in the organization. Finally, the time pressure on these decision makers was thought to be similar to a military combat environment. Decision points varied from those situations in which decisions had to made instantly to circumstances that involved hours or days in which a problem was defined and an option selected for action.

Wildland fire suppression activities are organized in such a way that fire teams of different levels of expertise are on call to respond to fires all across the nation. The firefighters on these teams undergo

extensive training both on the job and in classroom settings. Within the Incident Command System they are governed by a qualification system that documents their training and allows them to participate in firefighting at their own level of expertise. The fire teams themselves are categorized according to the expertise and experience of the team members. A Class II Overhead Team is qualified to fight fires that surpass the size and management capacity of local personnel. Class I Overhead Teams fight the very large wildland fires we see and hear about on national news, such as the one described above.

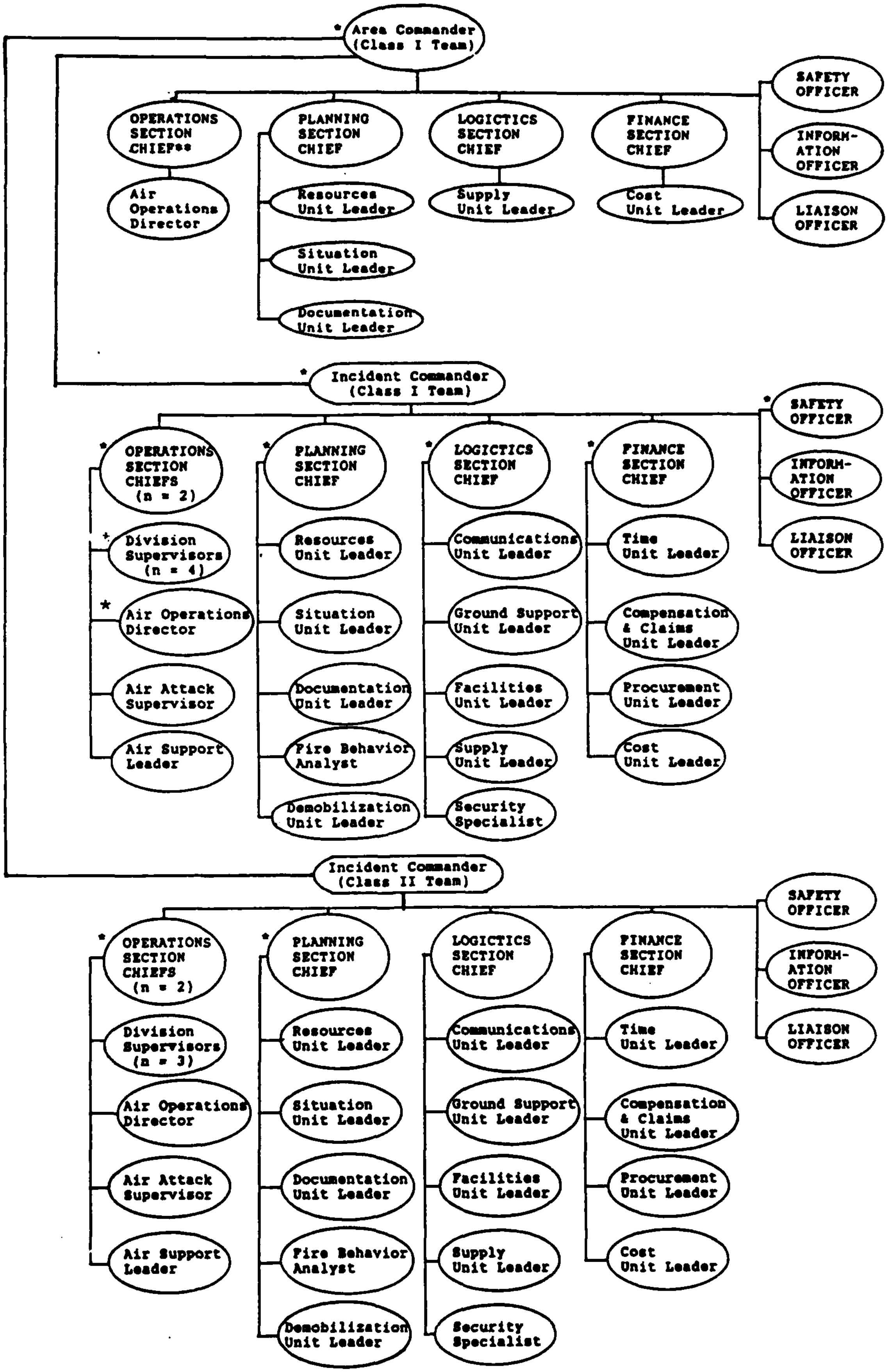
The Overhead Teams are organized into four functions: operations, planning, logistics, and finance. Each function is commanded by a Section Chief, with a tiered structure of command under him representing different levels of responsibility and subfunctions within the section. An Incident Commander heads the team. A Command Staff consisting of an Information Officer, Safety Officer, and Liaison Officer assists the Incident Commander. The teams are comprised of standing members of experts in each function and position. Line personnel (on-the-line firefighters) are recruited from local and regional pools of qualified men and women.

An Overhead Team consists of 25-35 people, depending upon the area of the country in which the team is based. In most instances, the full complement of firefighting experts is taken to a fire. When circumstances warrant, a short team will be assigned which consists of 8 people. The people on both the long and short teams are all experienced management personnel with command responsibilities for their own functions.

During this study, many fires were burning in close proximity, producing a situation in which a Class I team was called to the scene to command and co-ordinate <u>all</u> fire suppression activities in the area. Another Class I team was charged with fighting the largest fire in the area. Several Class II teams were each responsible for a number of smaller fires.

Data were collected at each of these levels of command responsibility. Two observers lived with the firefighters for eight of the days during which the participants in this study fought the fires. During this time we observed decision making at the Area Command level (staffed by a Class I team), at the Class I fire (staffed by a another Class I team), and at one of the Class II fires (staffed by a Class II team). Figure 2 shows the command structure of this organization and the levels at which we collected data.

Figure 2. Organizational Structure



*Denotes the positions at which one or more data points were collected.
**The composition of the Area Command Team differed slightly from that which is typically taken into the field.

Source of Data

Seventeen men, fourteen from the Class I teams, and three from a Class II team, participated in this study.[2] These men were experts in their field as seen from their experience and training. The median amount of firefighting experience was 24 years. Besides actual firefighting experience, each had received extensive training in a progressive training structure that is designed to develop and document qualifications and thereby enable the participants to graduate through the layers of the command system. Thirteen of the 17 men were qualified to perform functions for the team other than the one they typically performed or the one they executed on this fire (for example, an Operations Section Chief being qualified to serve as a Planning Section Chief).

Data Collection Procedures

The Critical Decision method (Calderwood et al., 1987; Klein et al., 1986) was used to collect data. Data were collected on site during the course of the fire three months and five months after the fire.

On-site observation. On-site observation was accomplished in several ways. The process by which the decision makers acquired information about the fire situation was observed during the regular planning and briefing sessions of the Overhead Teams. Two planning meetings were held every day by each of the teams. Twc briefing meetings also were held each day. These meetings were held at regularly scheduled times, thus allowing observation of the extensive communication process. During the meetings the fire team members exchanged information and discussed problems and solutions about critical matters such as the issues encountered in moving crews to the lines, the support of those crews on the line, the resting and recycling of the crews, and the acquisition of resources to fight the fire. Because issues such as these require the coordinated activities of the Chiefs, their staff, the Incident Commander, the command staff, and other members of the team, these meetings provided an excellent opportunity to observe the growing situational awareness of the team as a whole and for the individual members.

Other meetings occurred that focused upon special problems encountered during the course of the fire. Again, these meetings allowed the observation of communication of elements of situational awareness among the key members of the fire management teams.

Much of our time was spent in observing and interacting with the members of the team on an individual basis. Because these men were very

---

[2]Many women firefighters labored beside their male coworkers on this fire. However, the members of the Overhead Teams who participated in this study were men. Consequently, the word "man" and the pronoun "he" will be used extensively throughout this paper. No intention has been made to slight the women on this fire or to diminish their contribution by the use of this phrasing.

busy at their own tasks, special care was taken not to intrude while they performed their tasks. Decision points were probed while riding with a commander or chief in a vehicle, while eating a meal, or at other such times when their duties allowed.

Data collection after the fire. Additional information was collected in order to increase the number of decision points in the study. This occurred three months and five months after the fire. All data collected after the fire were obtained by the same observer who worked with the men on the fire. The three-month follow up information was obtained in face-to-face interviews. The five-month interviews were conducted by telephone.

One hundred and ten unique decision points were collected. Fifty decision points were obtained on the fire in face-to-face interviews, 28 were collected three months later in face-to-face interviews, and 32 were acquired by telephone interviews 5 months after the fire.

Selection of decision points. It must be pointed out that we were unable to select decision points at random. We had to probe the incidents we observed or those thought salient by the decision makers themselves. Sixty-eight decision points (62% of the total) were identified by the men themselves. This was accomplished by asking them to choose the most critical or important decisions they had made on the fire. (This was done both on-site and after the fire.) Forty-two decision points (38% of the total) were identified by the interviewers because these decision points had been observed on the fire and thought to reflect critical points in action or points at which the decision makers made commands.

Time after the decision point. Only 5 decision points were probed at the time the men made them. The remainder of the on-site decision points were probed within two days after the decision points had occurred. Of course, interviews conducted off-site occurred 3 and 5 months after the incident.

Interview structure. A semi-structured interview format was used for the face-to-face interviews conducted three months after the fire and for the 5 month telephone contacts. The on-site interviewing format, by necessity, was less structured because of the circumstances in which the data were collected (in some cases we were interrupted by events of the fire), but followed the general format outlined below.

We asked the participants in this study to describe what led up to the decision point. We asked them to tell us about their overriding concerns at that decision point, and probing to learn what they thought might happen or what they feared might happen at this point. We asked them to identify the features of the situation that allowed them to recognize what might happen, or what they feared might happen, if they did not intervene. We asked them how they knew what the problem was and what to do about it. Each man was asked about what he was intending to accomplish at that particular decision point. The amount of time spent in making each decision was probed along with the actual content and subject of their deliberation (if they did deliberate). Being careful not to

overburden our decision makers with redundant questions, in some instances we omitted the question of what led up to the situation because we had been there and knew the background of the situation. (See Appendix A for the interview questions.)

Verbal Reports

The verbal reporting at the decision points was extensive and of high quality. These decision makers had no trouble responding to our questions and were able to share their knowledge and thoughts with us, even though we were not firefighters.

An example of the type of information we collected at each decision point is seen in the following incident.

> This decision maker had been supervising his crews in digging fire control line in an area between several steep ridges that was inaccessible to bulldozers. Visibility had been poor due to weather conditions that had produced an inversion, keeping the smoke from the fire close to the ground for several days. The lack of visibility had seriously reduced aerial reconnaissance. Even on the ground, visibility in their area had been severely limited.
>
> In the early afternoon the inversion had started to lift. Immediately, the decision maker had begun to notice an increase in fire activity. He told us he could actually see the fire burning which, due to the limited visibility, he had been unable to do for several days.
>
> Because there were many fire teams in the area, several fire management teams had been forced to share the same radio network, thereby overloading the command network and hampering communication within each fire. To correct this, the decision maker's own team was changing the frequency for its command repeater. As the inversion was lifting, accompanied by the increase in fire activity, the decision maker had received word that the command repeater would be down for a short time while the radio technicians were changing radio frequencies. A relay was to be put on a mountain top until the repeater was reinstalled.
>
> This had special meaning to him because he was "down in a hole" and might be inaccessible to the relay on the mountain top, thus limiting his information about fire behavior in a situation in which it could rapidly change. This, combined with the changing burning conditions, had made "warning bells go off" in the decision maker's mind. Because he might not possess as much information as normal in a situation that could change, he recognized this as a potentially risky situation in terms of safety of the crews.

During the next 20 to 30 minutes, he had evaluated his situation. He knew there was a creek filled with water at the bottom of the ridge and that it would provide a place of safety in the event the fire moved rapidly in their direction. He knew the direction of the winds. Observers in three locations above him had reported no immediate fire activity. As a precautionary measure, however, he had asked for a helicopter to fly the area to look for fire below them. He was concerned about fire spotting across the ridge from the side on which it was burning to the side on which they were working. He did not want to be in a situation in which fire was burning below them. He had briefed his crews about what he would expect them to do if they were threatened by the fire.

Shortly after briefing the crews on escape routes, he started "sensing something was amiss." He then received several cues in rapid succession. He received a radio report from an observer who had seen a white puff of smoke on their side of the ridge. A second report was received indicating smoke below them, on their side of the ridge.

At this point the decision maker commanded his crews to implement the escape route he had previously outlined to them. They were told to go directly down the hill to safety. The combination of cues alerted him that immediate action was needed. He told us that he "just felt we had better get moving."

His action was immediately followed by an observer telling them the fire was on its way. Then he heard the roar of the moving fire and saw the smoke accompanying it in its path.

<u>Coding</u>

Following the lead of Calderwood et al. (1987) and expanding on this work, each decision point received a coded value for X (the identification of the situation) and another value for Y (the selection of the option). If an expert used multiple decision-making strategies on either or both dimensions, each strategy was coded. The coding scheme is shown below.

<u>"X" and "Y" Dimensions</u>

On the X, problem definition side, the coding categories were:

1- Immediate situation recognition. The person immediately the situation. He immediately recognizes the pattern or definition of the situation.

2- Verify situation. The person confirms that he is in situation X. The identifying characteristic in this category is that the person consciously <u>verifies</u> that he, indeed, is in situation X. He looks

at critical indicators, maybe at the rest of situation as well, to determine if this really is a situation of X.

3- Situation monitoring. The identifying feature here is that the person has a good idea of what the situation is or what it will develop into. The situation is monitored to determine if the initial recognition of its potential development is true. (The action that is taken when the situation does crystalize may be any on the Y dimension.)

4- Serial evaluation of situation. The person deliberates about the nature of the problem. He forms and tests hypotheses about the nature of X. He considers one hypothesis (Is this a situation of ____ ?) and then adopts it unless the evaluation is negative, in which case he moves on to the next hypothesis. However, there is no concurrent evaluation of one hypothesis vs. another.

5- Concurrent evaluation of situation. The person doesn't really know what X is. He defines X for himself by simultaneously considering different hypotheses and their relative strengths and weaknesses.

The coding categories for the Y, option side, of the decision point were:

A- Automatic response. The option or action is tied to a particular definition of X. It is part of an acquired pattern of action which dictates that the recognition of X elicits the automatic production of Y.
AUTOMATIC RESPONSES HAVE A SUBSET:
<u>C-control of automatic response.</u> What to do is decided automatically. How to do it or when to do it is deferred and ascribed only minor attention value.

B- Verify response. The person has a strong inclination to exercise a particular option, but consciously evaluates it or imagines it before actually exercising it.

D- Serial evaluation of alternatives. The person runs one option through his mind, determining its outcome, consequences, advantages and disadvantages. He cycles completely through one option (or as nearly through as he is able or inclined) before considering another option.

E- Concurrent evaluation of alternatives. The person compares at least one aspect of several options, such as the consequences of each option under consideration or the costs of each option under consideration.

Results

Before doing our major analyses, our first concern was whether we could obtain reasonable reliability between independent coders using the coding scheme described above. A second concern was whether the time at which a decision point was probed (on the fire, 3 months later, or 5 months later) affected the type of information we received. Finally, we wanted to assess the comparability of the results of the decision points selected by the interviewer as opposed to those selected by the firefighters themselves.

Quite respectable levels of interrater reliability were obtained.[3] Differences between the decision points probed on the fire and those probed 3 months and 5 months later were insufficient to warrant including time of interview as a variable in subsequent analyses.[4] Likewise, the differences between decision points selected by the interviewers did not sufficiently differ from those selected by the firefighters to necessitate this to be included as a variable in subsequent analyses.[5] Consequently, the variables of time of the interview and the source of identification of the decision point were collapsed and eliminated as factors in all further analyses.

---

[3]An interrater reliability study was conducted between two independent coders on a sample of 18 decision points. Interrater reliability was assessed separately for the X and Y dimensions. A 94% agreement rate was obtained on the Y dimension. For this analysis the Y codes had to be an <u>exact</u> correspondence before being categorized as a match. The degree to which they concurred about whether the activity was or was not recognitional was 89% on the X dimension.

[4]A Median Test was conducted between the on-site and follow-up decision points on the amount of time required to make the decisions. This analysis failed to show significant differences between the groups (median for on-sites = 1-5 minutes; for firefighters = 5-60 minutes; $\chi^2 = 3.17$; $\underline{df} = 1$; $\underline{p} > .10$). We also examined the frequency of the Immediate X/Automatic Y decision points (these types decision points are described in detail in the Results section of this paper) obtained on the fire, 3 months and 5 months later. An analysis conducted between on-site versus data collected after the fire revealed a trend for the on-site interviews to contain more Immediate X/Automatic Y decision points than those collected later. However, this difference was not significant (on-site = 38%; follow-up = 23%; $\chi^2 = 2.80$; $\underline{df} = 1$; $\underline{p} > .09$).

[5]No significant difference in time-to-make-the-decision was found between the decision points identified by interviewers and by the decision makers (median for interviewers = 5-60 minutes; for firefighters = 5-60 minutes; $\chi^2 = .10$; $\underline{df} = 1$; $\underline{p}$ = ns). Again, we compared the frequencies of the Immediate X/Automatic Y decision points, those identified by the interviewers to those selected by the firefighters. This comparison showed no significant differences (36% selected by interviewers; 26% selected by firefighters; $\chi^2 = 1.06$; $\underline{df} = 1$; $\underline{p} > .50$).

Types of Expertise Required

Our first examination of the verbal material from our decision makers made it very clear that these experts made decisions in several types of content areas. We saw two types of situations in which the men made decisions.

Functional decision points. The first category contained decision points which pertained directly to the man's functional responsibility. When an Operations Chief made decisions concerning the placement of fire control lines or the mode of attacking the fire, the decision points were categorized as functional. When a finance chief made the determination of whether and how to hire local resources, the decision points were categorized as functional. When the Safety Officer decided to keep a crew member off the line, again, the decision point was a functional one. For the decision maker, the relevant impact of these decision points was confined to his own area of responsibility. This category can be thought of as drawing upon the man's expertise for his actual job on the fire. (Examples of functional decision points are seen in the following pages of this report.)

Organizational decision points. On the other hand, the perceived relevant impact of the organizational decision points sometimes went beyond the decision maker's own functional area of responsibility. The second category called upon expertise that required the decision maker to work skillfully within an organizational structure and to be aware of the objectives and constraints of a variety of people other than those for whom he was responsible. These others were often other members of the fire management team. Sometimes they were people not on the team, such as local land managers or land owners. An organizational decision point was seen when one Section Chief would be aware of the effects of his decision upon another Section Chief and that Chief's people. In addition, these others' reactions to his decision could, in turn, affect the decision maker at a future time. An organizational decision point occurred when the Area Commander decided how he would geographically divide the fires in the area. He was aware of how this would influence the way he allocated the resources for which he was responsible. However, he also knew that the way he divided the fires would affect the national priority of several of the fires for which he was responsible and, thereby, his ability to obtain scarce resources to fight the fires. Therefore, the relevant scope and impact of his decision went beyond his own functional area of responsibility. In order to make the "right" decision he had to consider people's behavior outside his area of control. Thus, this decision was an organizational one.

A subcategory here contained decision points that were focused solely upon how the decision maker managed the people who were under his command. These concerned standard personnel issues such as performance evaluations and replacement of staff.

Several examples of organizational decision points may be found in Appendix B.

Seventy-two percent of the decision points were categorized as functional, 28% as organizational.

Development of Situational Awareness

The decision makers could seldom rely solely upon their own direct perception of events to keep abreast with their situation. Instead they had to rely upon information from others. This occurred in the form of formal written communication, visual material, and verbal communication, both formal and informal.

Formal written material was transmitted in the twice daily shift plans that were distributed through the organization. The shift plans outlined the objectives for the upcoming shift and the way in which crews and materials would be allocated. The size and location of the fire were tracked on large maps that were a focal point of planning and briefing sessions. Additionally, as expected, a large amount of information was communicated verbally, both in and out of the regularly scheduled meetings.

We had expected that verbal communication from other people would be an important component in the way these experts acquired information. The results of a content analysis revealed that 88% of the decision points depended on information obtained from verbal communication from other people.[6]

Information was obtained from people in the same chain of command, such as in the previous example of the decision maker learning from one of his scouts that smoke was below them. Information was also obtained from people outside the usual chain of command, such as between Section Chiefs in the planning meetings.

The complexity of these decision makers' tasks of keeping track of their rapidly moving situation was seen in the amount of information that was received from <u>both</u> within and outside their own area of command. In over half (55%) of the decision points, critical information was communicated both from within and outside the decision maker's own area of responsibility.

The need to assimilate large amounts of information about a rapidly moving and complex situation makes special demands upon decision makers.

We found that these experts had a clear set of expectations about the likely course of events at each decision point. This was reflected in their answers to several of our interview questions. We had asked them,

---

[6] We used a very conservative coding strategy for this analysis. At each decision point, we specified that the information from others must have been recent. It had to have been directly heard by the decision maker. It had to have been a driving factor in the decision, being cited in the interview as another's opinion, goals, or intentions.

"What were your overriding concerns at this time? What did you think might happen? What were you afraid might happen if you did not intervene?"

Every decision maker readily gave very meaningful responses to these questions, citing anticipated events he wanted to occur or prevent from occurring. (An example of this may be seen in the incident described earlier in which the decision maker was anticipating the location and movement of the fire.) The features of the situation ranged from static, concrete events in the environment to the goals and intentions of others.

Evidence for the role of expectancy was seen in another form. We knew, in this environment, that team interaction was crucial to the effective management of fire control activities. We speculated that a critical determiner of making the team concept work would be how well the decision makers knew and understood what other team members were trying to accomplish and whether they took others' aims into consideration when making their own decisions. Thus, the knowledge of the expectancies of others was thought to be a key element in these experts' situational awareness.

Accordingly, a content analysis was conducted in which the men's knowledge of other people's intentions and goals were evaluated. Eighty-five percent of the decisions were judged to have been made in a situation in which the decision maker's knowledge of the goals and intentions of other team members was a <u>critical</u> element. In nearly three quarters of these cases, the decision maker directly stated that he was aware of the goals or intentions of other people.

The example cited earlier can be used to illustrate these points. At the point where the decision maker ordered his crews to go immediately to the safety of the creek bottom, his current knowledge of the situation included his understanding of the burning potential of the fire. His expectations of likely events incorporated the knowledge that the fire could rapidly change its location and burning rate, thereby preventing his crews from reaching safety. He was alerted to the potential danger of his situation by several environmental features. He could not see, for himself, what was occurring and had to rely upon others for information. One of the people on the ground who was giving him information was over a mile away. He was worried about distance distorting the man's perception of the ground in question. He could not be absolutely sure that he and this observer were talking about the same ground and was aware of the magnitude of the consequences of making an erroneous evaluation of the location of fire. When his own scout reported seeing smoke below them, another critical marker was present to indicate that the fire could be a threat to them. At that point, the risk became too high to remain where they were and he ordered his people to go to the creek bottom.

<u>Decision Making Strategies</u>

The results of coding the data using the coding scheme described earlier are presented in Table 1. Table 1 is drawn so that the RPDs are

Table 1

<u>All</u> Decision Points

<u>Y</u>

<u>X</u>	Automatic Y	Verify Y	Serial Y	Serial/ Concurrent Y & Concurrent Y	Total X
Immediate X	1A a 24	1B b 2	1D c 4	1DE & 1E d 7	37
Verify X	2A e 5	2B f 5	2D g 2	2DE & 2E h 6	18
Monitor X	3A i 9	3B j 0	3D k 0	3DE & 3E l 4	13
Serial X	4A m 5	4B n 0	4D o 0	4DE & 4E p 2	7
Serial/ Concurrent X & Concurrent X	45A & 5A q 4	45B & 5B r 0	45D & 5D s 1	45DE & 5DE 45E & 5E t 30	35
Total Y	47	7	7	49	110

NOTE: 1A, 2DE, etc. refer to assigned codes.

represented in cells a, b, c, e, f, g, i, j, k, m, n, and o. These are enclosed in the double lines. Each cell represents a unique combination of cognitive activity on X and Y. For example, cell a represents the frequency of decision points at which an immediate recognition of X is accompanied by an automatic selection of Y. Cell c is characterized by an immediate recognition of X followed by a serial evaluation of Y.

Decision points at which several strategies were used on a dimension were recorded in the most deliberative cell. For example, if concurrent evaluation occurred in conjunction with any other form of cognitive activity on that dimension, the decision point was coded as concurrent on that dimension (cells d, h, l, p, q, r, s, t, outside the RPD box). By definition, if either the X or Y dimension was coded as concurrent evaluation, the decision point was not an RPD.

Recognitional Behavior on X

Recognitional processes are a central component of expertise. Recognitional behavior on both the X and Y dimension are important elements of expert decision making. Each is important in its own right. Consequently, the following paragraphs will describe recognitional behavior on each dimension separately. This will be followed by reporting the intersection points of the two dimensions.

Immediate Recognition of the Problem on X. The ability to immediately recognize a situation or problem in a high impact, rapidly moving situation is a valuable component of expertise. Our first analyses of the decision-making strategies used by these experts was to determine the frequency with which they were able to instantly recognize the type of problem with which they were confronted. At these decision points, the definition of the problem on the X dimension occurred instantly. The action that subsequently followed on the Y dimension could range through any of the conditions represented by the columns in Table 1.

Some examples from our data base will help to illustrate these types of decision points.

> The decision maker in the previous example reached the creek bottom safely with his 80 people and all their equipment. After making sure that everyone was accounted for, he rested his crews for a short time. During this time he gathered more information about his situation, conferring with one of his scouts to learn more about the terrain around them and what they could expect to find further down the creek.
>
> He then returned his attention to the crew. Finding them rested, he reached the next decision point. He ordered them to clear the brush in the bottom around the creek bed. His intentions in ordering the crews to brush out the bottom were twofold. He wanted to keep them busy in order to prevent them from becoming unduly alarmed about the fire around them. In

addition, in the event that fireshelters would have to be deployed, he wanted enough space to do so.[7]

The cues in the situation that alerted him to take this action were several. The resting crews' looking around at their situation was one feature of the environment. Another was the presence of considerable amounts of small green willows along the creek bottom in the location in which shelters would be deployed if that became necessary.

He told us that he did not deliberate about making this command. He just looked at the crews and knew he had to get them busy at a task.

This decision point was coded as Immediate X/Automatic Y and was counted in cell a. It was a functional decision point.

Another example of an Immediate X may be seen in the following decision point.

During a period of time in which the fire was burning very rapidly, radio traffic on the command network that served this fire was heavy. Many people were sending and receiving messages.

The decision maker in this incident heard one of his people describe fire activity in a manner that he believed to be unlikely, given his own knowledge of the person's position and the location of the fire. The moment he heard the communique, he recognized that the description of the situation was erroneous and could have undesirable consequences. He immediately recognized the problematic aspects and consequences of this type of radio traffic.

He deliberated about his own course of action to prevent a reoccurrence of this type of faulty communication. In his deliberation he considered the impact of his corrective action upon his own people and the long range effect upon the communicator and other people. He chose a corrective action and implemented it.

Even though deliberation has occurred on Y, no contemplation about the problematic nature of the situation had been needed.

The decision point was coded as Immediate X followed by an option selection process that included both serial and concurrent operations. This decision point was counted in cell d. It was an organizational decision point.

---

[7] Every firefighter is required to carry a fireshelter. When deployed, the shelter covers the firefighter like a small pup tent. The firefighters lie under the shelters until the fire passes over them.

We found that these expert decision makers were able to immediately recognize the problem (X) at 34% of the decision points.

Verify X. An example in which the decision maker quickly verified the nature of X may be seen at the following decision point.

> Shortly before the decision maker in the first example took his crews to the creek bottom, another decision point was occurring at a different part of the fire.
>
> As the inversion began to lift, another fire management expert in the course of his duties was traveling on a road a distance away from our first decision maker. While on the road he observed an increase in the fire's intensity. Trees were torching. He saw a small convection column and observed black smoke. Below the road there was unburned fuel. All this amounted to a likelihood that the fire could rapidly escalate and overrun the road.
>
> Being concerned about the safety of personnel who might use that road and about losing vehicles if abandoned, he ordered that stretch of road to be closed. The observation of this decision point indicated (and the decision maker corroborated the observation) that he had deliberated, even though for only a very short time, about the safety of people and equipment using the road and then had ordered it closed.

In this example the decision maker had an initial notion about the nature of the problem, but thought about it for a short time in order to verify his assessment of the situation. In this case, his order to close the road was the response that was cued by his assessment of the situation. The decision point was coded as Verify X followed by an Automatic Y and counted in cell e. It was a functional decision point.

Monitoring the situation on X. Another type of recognition of X was observed. The unique characteristic of these decision points was that a situation was recognized as one that would require action, at a later time. Usaually at these decision points the expert immediately recognized critical features in the environment that indicated the situation would develop to a critical point. When the course of events reached that point, he knew that action would be required on his part. Thirteen instances of this type of recognition of X were observed.

An example of this type of recognition, that the situation would evolve to a point where action was mandatory, may be seen at the following decision point.

> This decision point occurred at Area Command where the experts were responsible for command and coordination of all fire suppression activities in the area. In the preliminary staffing of the many fires, several Class II teams were each charged with a specific fire. One particular fire was growing very rapidly,

> a fact which alerted the decision maker that the amount of people and resources needed to fight the fire would reach a point at which the skill and management expertise of a Class I team would be needed to manage that particular fire.
>
> The decision maker monitored the situation until the amount of burning acreage, weather conditions, fuel conditions, and personnel requirements reached the state of his predictions. At that point he ordered a Class I Team to the fire.

His recognition of how the fire would develop was made on the basis of weather conditions, fuel, and the size of the fire. This recognition on the X dimension occurred a full day before his predictions were confirmed and action was taken on the Y dimension. This decision point was coded as Monitor X followed by an Automatic Y and counted in cell i. It was a functional decision point.

Serial X. An example of a decision point that was coded as serial evaluation on the X dimension may be seen in the following incident.

> Supporting the many men and women required to fight the fire was a large and complicated job. One of the tasks required to maintain a reasonable level of comfort and health was to provide showers for the crew members. Besides bringing in the shower facilities, water for bathing had to be transported to the fire camp. Potable water was required for use in the showers.
>
> The job of the decision maker in this incident was to monitor and assure the health and well-being of the crews. While performing his duties, he was confronted with a situation in which he suspected that a tanker filled with water ready to be delivered for use in bathing did not carry potable water. He knew this type of tanker ordinarily was used to put water on the local roads. He also knew that, quite typically, these trucks obtain water for use on the road from sources that do not contain drinking water. Therefore, he suspected that the tank on the truck would contain residue from previous loads when the truck was employed in its usual capacity.
>
> He asked the driver where the water was obtained for this truck while performing regular duties (not carrying water to the firecamp) in order to substantiate his notion that the water was very likely to be unsuitable for bathing.
>
> When the driver's answer confirmed his suspicions, his determination of the situation was complete. He knew the water was not suitable for use in the showers and he needed no further deliberation about the definition of the problem.

The serial nature of the deliberation on the X dimension can be seen in the way his initial hypothesis about the suitability of the water was thought out and then tested.

Having determined the nature of the situation, no deliberation was needed to select the correct option. He turned the driver away.

This decision point was coded as Serial X followed by an Automatic Y. It was a functional decision point.

The four types of recognitional X comprised 68% of the data points.

Recognitional Behavior on Y

Automatic action on Y. The capacity to call upon an automatic response (Y) is a valuable tool for the expert decision maker. Our next set of analyses was conducted to determine the frequency with which these experts relied upon an automatic course of action. At these decision points, the action was automatic, regardless of how they identified the nature of the problem (X).

Two types of automatic action were recorded. One was seen in the example above in which the decision maker's automatic response was to close the road threatened by fire. (Thirty-two percent of all the data points were this type of Automatic Y.)

Another type of Automatic Y was seen in which the selection of the option was automatic, however, the timing of its execution was put off until such a time that its effectiveness would be optimal. In these cases there was no deliberation about what to do. Neither was there any deliberation on when to take the action. The decision maker instantly decided that he would take a particular type of action when the time was appropriate.

A decision point of this type is illustrated below.

As the fire grew larger, more people were called to augment the Overhead Teams. A very experienced decision maker in this incident made several decisions upon his arrival at the fire. At the decision point in this example, he decided that he would advise another team member (as was part of his job) to restructure the way that man was performing some of his job tasks. In this example, he immediately recognized what the man was doing incorrectly. He also knew exactly what to do about it. However, being wise in how to manage and motivate people, he put off telling the man until his advice would be heard and heeded. Advising the man about what to do was an automatic response to the situation, as was the putting it off until the proper time. As soon as the decision was made, it received only little attention thereafter from the decision maker.

This decision point was coded as Immediate X followed by a Control of Automatic Y. It was a functional decision point.

Eleven percent of the decision points were this type of Automatic Y.

The results of our analyses in even his complex task environment showed that these expert decision makers were able to rely upon an automatic course of action at 43% of the decision points. Regardless of how the nature of X was determined, once the nature of the problem was known, these decision points required no further contemplation about what course of action to follow.

<u>Verify Y</u>. Verifying Y entails the rapid recycling of a decision maker's automatic response. It can be thought of as a means of quickly checking the automatic response to a situation.

An example of this was seen when a dramatic change in fire behavior occurred.

> During the course of the fire, a decision maker realized that the fire's reaching a particular landmark (crossing a creek) necessitated a strategic change to be made in the way the fire was being fought.
>
> He told us that once the fire crossed the creek, it was obvious that a change had to be made, even though this would necessitate massive changes from other functional areas of the team, entail extra resources to be obtained from outside the team, and make the local community wait longer for the fire to be extinguished. He briefly cycled through his chosen course of action before coming to closure on the issue.

Making the change in strategies was the response and it was generated automatically by the situation. However, the decision maker revisited it, although only briefly, to verify it's soundness. (In this particular case, he also quickly verified his assessment of the situation thus performing a Verify X operation.)

This decision point was coded as Verify X followed by Verify Y and counted in cell f. This was an organizational decision point.

<u>Serial Y</u>. An example of serial deliberation of Y was seen at the following decision point.

> One of the primary duties at Area Command was to coordinate the use of resources and to assure that adequate personnel and equipment were obtained for fighting the fires in the area. During the time in which these fires were burning, many other fires were burning in other parts of the country as well. Consequently, resources were scarce. Crews were sent from one fire to the next without having the opportunity to go home before being called again.
>
> In this area, one particular fire had received low priority in terms of its danger to life and property and with respect to the resources value of the land that was burning. Therefore, the

> decision maker in this incident had yet to assign an Overhead Team to it or to order the line personnel to fight it.
>
> When the opportunity came to assign personnel to that fire, the decision maker deliberated about the number of crews to have on the way for the Overhead Team. He evaluated what the crew complement could do, found it to be satisfactory for the situation, and did not explore another option.

This decision point was coded as Immediate X followed by Serial Y and counted in cell c. [illegible] was a functional decision point.

The three categories of recognitional Y described above made up 55% of the decision points for Y dimension.

<u>Recognition Primed Decision Making</u>

Even in this complex command and control environment, extensive recognitional behavior was observed. Seventy-three percent of the decision points received recognitional codes on <u>one or the other</u> of the X and Y dimensions. Fifty-one percent of the decision points in this study received recognitional codes on <u>both</u> the X and Y dimensions (the "pure" RPDs).[8]

<u>Immediate recognition of X accompanied by automatic action on Y</u>. One of the most interesting types of behavior of these experts were the decision points where behavior was automatic on both the X and Y dimension. This type of decision making strategy is one in which the decision maker's action is triggered automatically by an instant recognition of the situational problem. By definition this is a quick decision, but as will be seen in the following example, is not a trivial one.

> This incident involves the decision maker riding in the truck.
>
> After closing the road, and prior to the time at which our first decision maker took his crews to the safety of the creek bottom, our expert in the truck received word that radio technicians were changing the frequency of the command repeater. He was told that the command radio network would be inoperative for a short time.

---

[8] It should be noted that the earlier Klein et al., (1986) study in which 80% of the decision points were RPDs did not have access to as detailed a coding strategy as was used in this study. In Klein et al., our work had not yet made the differentiation between X and Y in the coding taxonomy. Therefore, what we call concurrent X in this study, if accompanied by a recognitional Y in Klein et al., would have been coded as a RPD. Consequently, even if there were no differences in the task environment, the earlier findings of the frequency of RPDs would be expected to be higher than those found in this study.

Several divisions had just reported increased fire activity. He could see for himself that the inversion was lifting and that the fire was intensifying. The types of activity he had seen told him that it could escalate even more rapidly. He had already closed a portion of a road because he feared it might be overrun by the fire.

His immediate response was to order the radio technicians to delay action until a relay could be established on a mountaintop to allow continuous communication to occur. He was concerned, at this time of escalating burning conditions, that his people might need the command network to be fully operative in order to coordinate suppression activities and utilize air support.

When observing this decision, it was seen (and corroborated by the decision maker) that the situation was recognized instantly as being one that was untenable for him. His solution was automatic and he implemented it immediately. The decision point was coded Immediate X followed by Automatic Y and counted in cell a. This was a functional decision point.

Twenty-two percent of all the decision points were categorized as an Immediate X followed by Automatic Y.

Concurrent Deliberation

Despite the fact that much recognitional decision making was employed, these experts had call to engage in extensive concurrent deliberation at many decision points. Thirty-two percent of the decision points required concurrent deliberation on the X dimension; 45% of the decision points entailed concurrent deliberation on the Y dimension. Twenty-seven percent of the decision points required concurrent deliberation on both the X and Y dimension.

A methodological note must be made about these findings, however. It will be remembered that when recognitional strategies were used in conjunction with concurrent evaluation (on either the X or the Y dimension), the activity was coded as concurrent evaluation. When these concurrent evaluation categories are examined in detail (see Table 2), it is seen that recognitional behavior was present in 41 of the 54 cases of concurrent evaluation!

When looking solely at the Y dimension, the dimension of interest for decision analysis, Table 2 shows that 35 decision points involved concurrent evaluation on Y. In 29 (83%) of these 35 incidents, recognitional strategies were also employed. Thus it may be seen that even when concurrent evaluation was used in this setting, it was accompanied by recognitional strategies.

TABLE 2

DECISION POINTS

CODED AS CONCURRENT EVALUATION

				X	
				d 1DE = 5 1E = 2	Immediate X
				h 2DE = 4 2E = 2	Verify X
				l 3DE = 2 3E = 2	Monitor X
				p 4DE = 1 4E = 1	Serial X
Y	q 45A = 2 5A = 2	r 45B = 0 5B = 0	s 45D = 0 5D = 1	t 45DE = 21 5DE = 6 5E = 3	Concurrent/ Serial X
	Auto Y	Verify Y	Serial Y	Concurrent/ Serial Y	

NOTE: 1A, 2DE, etc. refer to assigned codes.

Some examples from our data base reflect the types of decision points that were counted as concurrent evaluation. Returning once more to our decision maker with his crews in the creek bottom, we see an example of concurrent deliberation on both the X and Y dimension.

> After putting his crews to work in the creek bottom, the man's next decision point focused upon whether to keep his crews there, in a location that had some advantages with respect to safety, or to move them to another spot in anticipation of finding a more secure location. The location they occupied had the advantage of being beneath a cliff which was devoid of fuel. Consequently, if the fire approached the crews would be protected from fire on that side. The disadvantage of the cliffs was that if the fire reached the area <u>above</u> the cliffs, burning logs could roll off the cliffs onto the crews in the bottom.
>
> The decision maker told us he was afraid of becoming trapped in that location. He was unable to obtain aerial reconnaissance and therefore did not know where the fire was. He sent a scout further down the creek to determine if there was a better spot ahead and to learn more about the fire's activity.
>
> In fact, a better spot further down stream was discovered. There was more gravel in the area further down stream and it was not flanked by the sheer cliffs. In addition, they could see a small window of daylight even further ahead. After several minutes deliberation about both their situation and about the advantages and disadvantages of moving and staying, he gave the order to move on down stream.

At this decision point, the expert engaged in concurrent deliberation about both the situation and what he would do about it. The decision point was coded as Serial and Concurrent on the X dimension as well as Serial and Concurrent on the Y dimension. It was a functional decision point.

A final example from the decision maker in the creek bed illustrated another case in which only concurrent deliberation (not accompanied by recognitional activities) of options occurred.

> After wading through the creek in waist-high, rapidly moving water, the firefighters, carrying all their equipment, reached a place of safety and were given a rest. No longer so concerned about safety, the decision maker's goal shifted to getting his people back to firecamp quickly and easily. He learned from a scout that two routes led to transportation back to camp. One involved hiking further down the creek. The other entailed hiking up a steep ridge. Neither course was easy. Each had advantages as well as disadvantages.

In this case the decision maker evaluated each option simultaneously, comparing the time and effort involved in each option.

After several moments of weighing the two options a choice was made. A route was chosen and the crews and the decision maker returned safely to camp.

This decision point was coded Monitor X followed by Concurrent Y and counted in cell 1. It was a functional decision point.

We found decision points that required even more extensive deliberation on both the X and the Y dimensions. This was seen in the strategic decisions such as when one of the teams changed their attack mode from an indirect to a direct one. As would be expected, this entailed extensive consideration of situational elements such as weather conditions, terrain, predicted fire behavior, and local concerns to have the fire extinguished. It also involved a considerable amount of deliberation of alternative ways in which to fight the fire, such as where to build control lines, whether resources were available to build a line in a proposed location, and the types of consequences that would be incurred if the fire got away at any part of a proposed line.

Differences Between Functional and Organizational Decision Points

It should be noted that the aforementioned percentages were obtained for all the decision points collected in the study. It should be remembered, however, that we encountered two types of decision situations: functional and organizational.

Differences were found between the functional and organizational decision points (Tables 3 and 4 show the frequency of obtained results for the functional and organizational decision points.) The functional decision points entailed significantly less concurrent deliberation on Y than did the organizational decision points (functional = 38%; organizational = 61%; z = 2.215; p = .027). In addition, a significantly greater reliance upon an automatic course of action was found at the functional decision points than at the organizational ones (functional = 49%; organizational = 26%; z = 2.248; p = .025).

Differences were also seen between the frequency of the simultaneous occurrence of Immediate X and Automatic Y in the two groups. More Immediate X/Automatic Ys were found at the functional decision points than at the organizational ones (functional = 27%; organizational = 10%; z = 1.932; p = .053).

The two groups did not differ in their reliance upon recognitional processes on X (functional = 68%; organizational = 68%). However, when only the cases were considered in which immediate recognition of X occurred, an automatic response followed in 75% of the functional decision points. This occurred at only 33% of the organizational decision points. This difference was statistically significant (z = 2.280; p = .023).

Table 3

Functional Decision Points

Y

X	Automatic	Verify Y	Serial Y	Serial/ Concurrent Y & Concurrent Y	Total X
Immediate X	1A a 21	1B b 2	1D c 3	1DE & 1E d 2	28
Verify X	2A e 5	2B f 2	2D g 2	2DE & 2E h 5	14
Monitor X	3A i 6	3B j 0	3D k 0	3DE & 3E l 3	9
Serial X	4A m 3	4B n 0	4D o 0	4DE & 4E p 0	3
Serial/ Concurrent X & Concurrent X	45A & 5A q 4	45B & 5B r 0	45D & 5D s 1	45DE & 5DE 45E & 5E t 20	25
Total Y	39	4	6	30	79

NOTE: 1A, 2DE, etc. refer to assigned codes.

Table 4

Organizational Decision Points

X \ Y	Automatic Y	Verify Y	Serial Y	Serial/ Concurrent Y & Concurrent Y	Total X
Immediate X	1A a 3	1B b 0	1D c 1	1DE & 1E d 5	9
Verify X	2A e 0	2B f 3	2D g 0	2DE & 2E h 1	4
Monitor X	3A i 3	3B j 0	3D k 0	3DE & 3E l 1	4
Serial X	4A m 2	4B n 0	4D o 0	4DE & 4E p 2	4
Serial/ Concurrent X & Concurrent X	45A & 5A q 0	45B & 5B r 0	45D & 5D s 0	45DE & 5DE 45E & 5E t 10	10
Total Y	8	3	1	19	31

NOTE: 1A, 2DE, etc. refer to assigned codes.

The functional decision points contained more RPDs than the organizational ones. However, this differences was only marginally significant (functional = 56%; organizational = 39%; $z = 1.603$; $p = .109$).

In summary, these results speak to some of the components of expertise. These decision makers could rely more often upon an automatic response in the situations that employed their greater level of expertise (the functional decision points) than in the domain in which their expertise, although extensive, was not as great (the organizational decision points). They had to comparatively evaluate options less in the area of their greatest expertise.

Speed of Decision Making

It had been predicted that the range of time it took to reach a decision would be much larger in this environment than had been the case in the previous studies on recognitional decision making. This was found to be true (the median time for the entire sample was between five minutes and an hour. The median was 60 seconds in the Klein et al., 1986, study). It should be noted, however, that nearly a third of the decisions in this study were made in less than 30 seconds.

Discussion

This was an observational study of the command-and-control activities of a highly trained and very experienced group of decision makers. The domain in which these experts functioned was extremely complex, rapidly moving, and characterized by high impact of their decisions upon people and resources.

Decision-Making Strategies

We found that command-and-control decision making in this environment was comprised of much recognitional decision making. Over half of the decision points, in even this very complex setting, were RPDs. Recognitional behavior occurred on both the X and the Y dimension of the decision taxonomy. At over half of the decision points, options (Y) were derived by recognitional processes as opposed to concurrent evaluation of options. In over two thirds of the incidents the situation (X) was identified by recognitional processes.

We have speculated that the decision makers in this study differed in their expertise in the two types of decision situations. While these men possessed a great deal of expertise at the organizational decision points, we contend that their expertise was even greater at the functional decision points. We think this because of the way they work up through the firefighting organization to the command level. They start at the bottom, engaging in on-line fire suppression activities and then, through training and experience, rise to command positions. They acquire functional expertise as they are doing this. Consequently, they have had more experience and training in the functional category.

Accordingly, we found a greater reliance upon recognitional strategies at the functional decision points than at the organizational decision points. A greater frequency of automatically cued options was seen in the functional area than in the organizational situations. This suggests that the greater experience and training in their core area of expertise allowed the appropriate action to be cued more often than in the area in which the decision makers possessed a little less expertise.

Less reliance was placed on concurrent evaluation of options at the functional decision points than at the organizational ones. Again, the greater expertise at the functional decision points freed these decision makers to engage in other cognitive activities than generating and comparing options. Thus, they could think about other job demands and, thereby, expand their area of control. This has direct relevance to capturing the nature of expertise.

Only a marginally significant difference in the frequency of RPDs (where both X and Y were recognitional) was found between the functional and organizational decision points. While this did not reach conventional levels of statistical significance, it was in the right direction.

The high occurrence of recognitional strategies highlights an important strategy of decision making. An expert decision makers' tasks are more than selecting the best option from among many. They also must improve the options that are available. Soelberg (1967) described this strategy clearly, whereby the decision maker recognizes a favorite option and tries to improve it. In Soelberg's setting, selection of jobs, the improvement came through comparison of the favorite with alternatives to find weaknesses that could be overcome. In our setting, options could be improved without comparisons, simply by gathering criticisms about them. The planning sessions were useful for identifying weaknesses that needed to be addressed while at the same time finding ways of upgrading an option so that it could be more effective. The growth of options can be as important as the selection of options, for effective decision making.

Communication of Situational Awareness

These experts' decision making activities were driven and determined by the quality of their knowledge of their command situational. In turn, their situational awareness was determined by the type and amount of information obtained from others. Our informal observations indicate that the manner in which they communicated among themselves gave them the proper amount and type of information. We saw them as possessing as much information as they needed. Of even more interest, we observed no interference with performance due to information overload.

There is a concern about information overload in command and control environments. The fact that we observed no interference with performance due to information overload in this environment deserves exploration. We speculate that a variety of factors were responsible for protecting these decision makers from being overwhelmed by too much information.

First, the Incident Command System prescribes formal methods of communication, thus giving the decision makers ways of structuring information they want to transmit and an expected format in which to receive it.

Second, the way in which the firefighting organization grows in response to the demands of suppressing a fire prevents the overloading of its decision makers. The organizational structure to fight the fire grows only as large as is needed. In addition, they follow prescribed organizational procedures that limit each person's span of control. If the number of management people reporting to an individual team member becomes too large (5-7) after the Overhead Team is in place, that function or section is branched. In this way the decision makers are protected from becoming overloaded by information from too many sources.

Third, we speculate that the decision makers themselves store and update their situation in a manner that prevents them from acquiring information faster than they can assimilate it. We contend that their knowledge of others' intentions and anticipated actions serves as the basis of a shared model (or models) of firefighting behavior. Many of these decision makers have fought fires four or five months of the year for 25 years. They have very similar experiences. They have participated in a number of the same incidents. Other specific incidents in which they have not participated have become part of the folklore and, thereby, part of their own repertoire of meaningful information.

Their shared knowledge is not restricted to general principles of fire behavior, however. The Overheads are standing teams, comprised of the same members from year to year. They know the individual make-up of each of their own team members. Because they have worked extensively with their own team members, they can anticipate what the others will do and how they will perceive certain situations. They are aware of the goals and intentions of other members of the team (and in many cases, the local land managers and community). They know whose judgment they can trust and whose they cannot. In essence, they know what to expect from the people they work with as well as what to anticipate from the fire and resources to fight it.

We also suggest that the situational awareness of these decision makers is not restricted to static elements of information. Instead, their situational awareness is grounded in anticipated events that are flagged by past and current events. We think of highly expert situational awareness (a construct) as being arranged in predicted action scenarios. Future behavior of the fire, of crews, and of other key actors are as salient to these experts as past and current events.

In this type of distributed setting, the scenarios themselves are acquired through shared experiences and similar training. We contend that this type of expectancy-oriented, shared mental model is the basis of communication, allowing information to be organized and communication to be concise and predictable.

Distributed Decision Making

Because Fischhoff and Johnson (1985) have provided a perspective from which to view command-and-control distributed decision making, it may be enlightening to compare their ideas to our own experience.

They state that the most simple case of distributed decision making, a 2-person decision, would be characterized by shared goals, shared experiences, and effective communication. Even this simple case, however, can raise problems if two people share erroneous beliefs, being thereby likely to produce a false consensus. Nevertheless the real difficulties begin when complications are added. These would include the following: partially shared goals, partially shared experiences, unreliable communications, dependence on a formal language or communication channel that filters out non-verbal cues about attitudes, communication about knowledge that is not tagged by its source (thereby preventing users from evaluating its credibility), or the prevention of communications about confidence in situation assessments and in options.

The multiple-person decision adds more complexities. Now there can also be an explosion of information as the volume of messages increases. Should all people receive all messages, or should they be directed selectively and, if so, how? The tracking of messages creates its own burdens. As the size of the organization increases, the proportion of shared goals and experience will decrease. Biases may harden and become cumulative. If the organization attempts to decentralize communications, it runs the risk of instability, since the shared model becomes less feasible. It will have to delegate decisions of how orders are to be implemented, and solicit feedback to keep some semblance of a shared model. A final complication is the heterogeneous system, in which personnel with different specialties are used. This increases skill levels, but adds the problems of identifying the right people at the right time and making them available. It also affects personnel needs because it prevents interchangeability of people.

This is a gloomy picture of distributed decision making. How well does it describe the situation we studied?

The wildland forest fighting that we observed certainly appeared to represent a complex distributed decision-making situation. Over 4,000 firefighters were brought in to fight these fires. It was like building a large corporation of 4,000 workers in only a few days and expecting the workers to begin risking their lives immediately, secure in the skills of their commanders. Looking only at the job of the Incident Commander, how many people do we know who could assemble a large corporation and get it working effectively within just a few days time?

Many of the complications Fischhoff and Johnson (1985) described were found in the incident we studied. At the level of the 1-person decision maker there was often a high degree of uncertainty (as in the case of the decision maker in the creek bottom). It was a dynamic task (the level of success changed dramatically, as when a fire that had been considered to

be on its way to being contained "blew out" due to weather conditions and the attack mode had to be changed). However there was not a formal modeling language used.

At the level of the 2-person decision task, the goals were only partially shared. (The Area Commander's assessment that a Class I Team was needed to fight the largest fire did not correspond with the view of the on-site, Class II Team involved with fighting the fire.) There were partially common experiences, and communications were not always reliable (some of the decision points we probed reflected how the reliability of communication can fluctuate in this type of situation, such as the man being "down in a hole" when the command repeater was being changed).

Interestingly, the complications that Fischhoff and Johnson (1985) described for the multiple-person decision did not arise. There was not an information explosion. One reason was that radio communication was structured so this would not occur. Another reason was that the roles were understood and well-practiced. These people had fought many fires together and they had learned who needed which types of information. They could take the perspectives of the other players. The problem of the tracking of communications did not seem to be a burden here either. Their experience and skill made it unnecessary to waste resources on tracking each message.

Likewise, the problem of decreasing the proportion of shared goals as the organization increased did not arise. The vast amount of common experience dominated. Moreover, it is not as if there would be infinite numbers of unique goals operating. In reality, there can only be a relatively small set of goal options. A steady state of diversity will be reached. In our incident, this steady state did not encompass a large range of diversity. Moreover, the diversity was understood and represented fairly well--they had a good ability to take the perspective of others. (Remember how many of these experts' situational awareness reports included statements about the goals of other team members.)

Finally, there was not a problem of having heterogeneous parts. Specialization was necessary in this environment, but the skill level allowed good understanding of the requirements of other people.

In short, this was a very robust organization. The lengthy experience levels, the common experiences (these people had very frequently fought the same fires), the knowledge of other perspectives, all contributed to the organizational effectiveness. These experts could eliminate the "noise" of tracking messages by making sure the messages were effectively transmitted. They could avoid the problem of partially shared goals by being able to represent the alternative perspectives of the decision makers with whom they interacted. They relied heavily upon their knowledge of people to interpret the credibility of messages they received, and they were careful to keep the sources of messages identified. They overcame the bias of false consensus by being quick to challenge ideas. They overcame problems of unreliable communications by using expectations to detect early signs of unreliability.

Following Fischhoff and Johnson's (1985) hypothesis, orders were communicated about what was to be accomplished, and rarely about how to accomplish it. There was a high degree of trust in the people at lower levels. In cases where this trust was not well founded, subordinates were replaced. Also there was a perspective that the incident was a training opportunity as well as an operational mission. Good judgment was used in the way subordinates were treated, in the type of responsibility that was given and was retracted. The subordinates had their own careers, and their skills had to be carefully nurtured. They all knew how important it was to develop new team members and that was part of their goal structure.

Contrast between Wildland Firefighting and Military Command-and-Control

The first difference is that the "enemy" (the fire) they engaged was not a thinking and planning entity. Consequently, the events in their action scenarios would be more predictable than in a combat situation.

A second difference was the organizational make-up of the firefighting organization. The Overhead Teams have the same members from year to year. They have all worked with each other, sometimes for years. This facilitated communication and the sharing of mental models since they had developed their mental models from many of the same incidents.

A third difference is the set of procedures for promotion. The command staff comes up through the ranks. They have the most experience and the greatest ability. This was recognized, and because of it there was a great deal of trust in their decisions. This is a necessary ingredient in a situation in which people voluntarily work in circumstances that could be, and sometimes are, life-threatening.

The organization was lean on administrative staff. There did not appear to be much in the way of problems of large, permanent bureaucracies. Controlling costs to extinguish the fires is a primary concern of the Overhead Teams. This keeps unnecessary personnel and resources from adding to the complexity of the organization.

Conclusion

In conclusion, this study of distributed decision making showed the prevalence of recognitional decision making. It confirms earlier finding that more experienced decision makers use more recognitional strategies than less experienced ones. In this study, the distributed nature of learning about the command situation was investigated. It was found that these decision makers were not overwhelmed by information. It was suggested that a shared mental model underlies these experts' communication. A strong role for expectancy was seen in the way these experts learned and communicated the critical aspects of their command situation.

REFERENCES

Berkeley, D., & Humphreys, P. (1982). Structuring decision problems and the 'bias heuristic'. Acta Psychologica, 50, 201-252.

Brezovic, C. P., Klein, G. A., & Thordsen, M. (1987). Decision making in armored platoon command. Unpublished manuscript.

Calderwood, R., Crandall, B., & Klein, G. A. (1987). Expert and novice fireground command decisions (MDA903-85-C-0327). Alexandria, VA: U.S. Army Research Institute.

Ebbesen, E. B., & Konecni, V. J. (1980). On the external validity of decision-making research: What do we know about decisions in the real world? In Wallsten, T. (Ed.) Cogntive processes in choice & decision behavior. Hillsdale, NJ: Erlbaum.

Fischhoff, B., & Johnson, S. (1985). The possibility of distributed decision making. Prepared for Workshop on Political-Military Decision Making, The Hoover Institution, Stanford University.

Gettys, C. F. (1983). Research and theory on predecision processes (TR11-30-83). Norman, OK: University of Oklahoma, Decision Processes Laboratory.

Klein, G. A., Calderwood, R., & Clinton-Cirocco, A. (1986). Rapid decision making on the fireground. Proceedings of the 30th Annual Human Factors Society, 2. Dayton, OH: Human Factors Society.

Montgomery, H. (1983). Decision rules and the search for a dominance structure: Towards a process model of decision making. In P. C. Humphreys, O. Svenson, and A. Vari (Eds.), Analyzing and aiding decision processes. NY: North-Holland Publishing Co., 343-369.

Rasmussen, J. (1985). The role of hierarchical knowledge representation in decision making and system management. IEEE Transaction on Systems, Man, and Cybernetics, 2, SMC-15, 234-243.

Shanteau, J. (1984). Some unasked questions about the psychology of decision makers. In M. E. El-Hawary (Ed.), Proceedings of the IEEE Conference on Systems, Man, and Cybernetics. NY: IEEE.

Soelberg, P. O. (1967). Unprogrammed decision making. Industrial Management Review, 8, 19-29.

Swezey, R. W., Streufert, S., Criswell, E. L., Unger, K. W., & van Rijn, P. (1984). Development of a computer simulation for assessing decision-making style using cognitive complexity theory (SAI 84-04-178). McLean, VA: Sciences Applications, Inc.

Tversky, A. (1977). Features of similarity. Psychological Review, 84, 327-352.

Woods, D. D. (1984). Some results on operator performance in emergency events. In D. Whitfield (Ed.), Ergonomics problems in process operations (pp. 21-32). Institute of Chemical Engineering Symposium, Series 90. Elmsworth, NY: Pergamon Press.

Appendix A

INTERVIEW GUIDE

Time ______ Date ________

WILDFIRE GUIDE

NAME ________________________ DECISION POINT ________________________

____

____

Why chosen: ____________________________

____

OWN DECISION __________ PARTICIPATED IN THE DECISION __________

What led up to this decision? (SITUATION ASSESSMENT)

What were your overriding concerns at this time. What did you think might happen? What were you afraid might happen?

What was it in the situation that allowed you to recognize what might happen, what you feared might happen if you did not intervene? How did you know what the problem was or what to do?

What were you intending to accomplish?

Was there a goal(s) beyond that?

Did you DELIBERATE about this?

HOW LONG?

What did you deliberate about?

Had you ever seen anything like this in the past (either the problem or the solution to the problem)?

Did anyone else PARTICIPATE in this decision? HOW?

More specifically, what was YOUR ROLE in this decision?

Time ________

Appendix B

ORGANIZATIONAL DECISION POINTS

Example 1.

As the fires were coming under control, some of the resources could be transferred from one fire to another. Personnel and equipment were sent from a fire at which they were no longer needed to one in which their presence was much needed.

The decision maker in this example had both resources and personnel transferred to his command. The staff that was transferred to him were not part on his own Overhead Team. He had to integrate these people into his own chain of command, with himself clearly in charge.

The impacts of his decision would be felt on this fire within his own area of responsibility in that the way these people were integrated into his own staff would directly affect the way his organization would work. However, if he did not skillfully merge these people into his own organization, an impact would be felt upon other fire operations. In addition, he could anticipate working with the new staff again on another fire and in the course of his and their regular jobs off the fire. Consequently, the effects of his actions would not be limited to his own area of control.

When interviewing this decision maker, the long range effects were a salient consideration in how he chose the way in which to integrate the new staff into his organization.

Example 2.

During the course of fighting the fire a strategic change had to be made by the team responsible for fighting the fire. Because there was an Area Command Team charged with suppressing all the fires in the area, the on-site team needed to coordinate this strategical change with Area Command.

In preparing for the exchange, the Incident Commander of the on-site team had to determine whom he would take to that meeting and how he would use them to accomplish his objectives. His objectives were to get full support for what he intended to do, thus facilitating his tasks on this fire. Also, he wanted to preserve his own team's working relationships with that of Area Command and the local land managers, wanting the latter to be fully aware, then and after the fire teams had left, of why actions had been taken.

Example 3.

Before the largest fire in the area grew to the size at which a Class I Team was needed to fight it, a Class II Team had spent several days on that site. When the Area Commander called the Class I Team to the fire, the Class II Team could have been sent home. However, another fire in the command area was escalating to the point where it had to be staffed.

The Area Commander sent the Class II Team to that fire. He, thereby, saved the expense of transporting that team home and got the new fire staffed more quickly. (This much of the decision point was functional.)

However, another consideration, although not as salient, was in the Area Commander's mind. He was aware that when a Class II Team is relieved by a Class I Team, it is difficult for the Class II Team to have to give up the fire. Disappointment and bruised feelings often cannot be avoided. These feelings follow the men back to their own jobs and localities. Giving the Class II Team another fire in the area would alleviate some of these problems.

This decision point was classified as organizational because the Area Commander did have these latter considerations in mind, even though they were not the primary ones for sending this Team to the new fire.